ARE WE RUNNING OUT OF OIL?

"Functional Theory" Says No

By Robert L. Bradley Jr.

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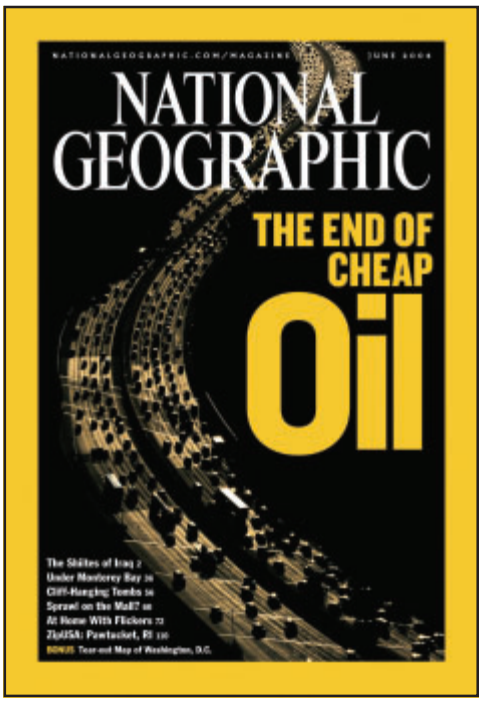
"This time it's for real," says the cover story of the June 2004 issue of *National Geographic*. "We're at the beginning of the end of cheap oil."



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Books and articles written by geologists, environmentalists, and others regularly announce a new era of increasing oil scarcity.[1] Today's resurrected hero of the depletionists is M. King Hubbert (1903–1989), a Shell Oil Company geologist who a half-century ago presented a bell-shaped curve depicting oil production over time. But the theory of a little-known twentieth century economist, Erich Zimmermann, suggests this is unsound.

Hubbert's model correctly predicted that U.S. oil production would peak around 1970. A sister prediction, that U.S. gas production would peak in 1970, was errant, however. And his prediction that global oil production would begin an irreversible decline around 2000 is off to a poor start (Hubbert 1956). World oil production in 2003 was about 2.5 percent above 2000 (U.S. Energy Information Administration [U.S. EIA] 2004b).

The logic behind mineral-resource pessimism is simple. It goes like this: Oil is a finite resource, incapable of being reproduced in human time frames. Any usage reduces the stock, and geometric demand growth, such as the 1.9 percent annual increase in oil demand predicted for the next two decades (U.S. EIA 2004a, 167), will rapidly deplete remaining supplies. Fixed supply plus rising demand equals depletion and increasing economic scarcity.

"But look at the data," expansionists respond. The resource base for different minerals has expanded tremendously over time to meet growing demand—and at steady, and even falling, prices when adjusted for inflation. Resource availability has been positively, not negatively, correlated to consumption when human ingenuity has been allowed free rein.

The expansionist position is often associated with Julian Simon, who in 1990 won the most famous wager in the history of economics. He bet Paul Ehrlich, John Holdren, and others that the inflation-adjusted price of mineral resources would be less in 1990 than in 1980, and it was. A similar bet undertaken today would likely be a winner, too. Prices of global oil and North American natural gas in recent years have been higher than their historical average, but supply and demand adjustments promise to bring these prices down over time—given access to reserves and entrepreneurial incentives.

The gulf between the depletionists and expansionists can be better understood—even resolved—by appreciating the insights of the functional theory of mineral resources developed by Erich Zimmermann (1888–1961), an economist at the University of North Carolina and later the University of Texas. His insight provides a theoretical foundation for modern expansionist thought.

Zimmermann rejected the assumption of fixity. Resources are not known, fixed things; they are what humans employ to service wants at a given time. To Zimmermann (1933, 3; 1951, 14), only human "appraisal" turns the "neutral stuff" of the earth into resources. What are resources today may not be tomorrow, and vice versa.

"Resources are highly dynamic functional concepts; they are not, they become, they evolve out of the triune interaction of nature, man, and culture, in which nature sets outer limits, but man and culture are largely responsible for the portion of physical totality that is made available for human use" (Zimmermann 1951, 814–15). Zimmermann concluded that "knowledge is truly the mother of all resources" (10).

Zimmermann drew a clear distinction between the ways in which natural scientists and social scientists view resources. "To the physicist the law of the conservation of matter and energy is basic. The economist, however, is less interested in the totality of the supply than in its availability" (Zimmermann 1933, 45). He warned: "To those who are used to view resources as material fixtures of physical nature, this functional interpretation of resources must seem disconcerting" since "it robs the resource concept of its concreteness and turns it into an elusive vapor" (4).

Physical to functional; objective to subjective; absolute to relative; static to dynamic; one-dimensional to institutional—Zimmermann's real-word theory was ignored by the economic orthodoxy in its quest to remake their discipline into a "hard" science based on mathematical relationships. Economists embraced deterministic ideas of known, fixed resources that enabled them to calculate the "optimal" extraction rate of a "depletable" resource (Krautkraemer 1998). But it was at the expense of understanding the dynamics of real-word resources.

Depletionists-qua-alarmists err on their own ground by neglecting the vast size of the estimated carbon-energy resource base. The World Energy Council (2001, 161) has concluded that "fossil fuel resources are adequate to meet a wide range of possible scenarios through to 2050 . . . and well beyond." Similarly, the Intergovernmental Panel on Climate Change (IPCC) found that fossil fuels are so abundant that they "will not limit carbon emissions during the 21st century" (IPCC 2001, 4). The IPCC estimates that only about 1.5 percent of the total physical resource base of the Earth's crust was produced and consumed between 1860 and 1998 (236). Such supply represents, potentially, many thousands of years of increasing consumption (Bradley and Fulmer 2004, 91).

Geologists divide the earth's resource base into three categories: "proved" (found and ready to be produced), "probable" (expected to become proved in time), and "speculative" (estimated but uneconomic). *Resourceship*—that is, entrepreneurial development of resources—turns probable into proved, and speculative into probable (McDonald 1995). What is high cost today becomes lower cost tomorrow. Heavy oils, such as orimulsion in Venezu-

ERICH ZIMMERMANN'S FUNCTIONAL THEORY OF RESOURCES

ERICH ZIMMERMANN
(1888–1961)

RESOURCES & MAN

"Previous to the emergence of man, the earth was replete with fertile soil, with trees and edible fruits, with rivers and waterfalls, with coal beds, oil pools, and mineral deposits; the forces of gravitation, of electro-magnetism, of radio-activity were there; the sun set forth its life-bringing rays, gathered the clouds, raised the winds; but there were no resources." (1933, 3)

RESOURCES & INSTITUTIONS

"*A functional interpretation of resources . . . makes any static interpretation of a region's resources appear futile; for resources change not only with every change of social objectives, respond to every revision of the standard of living, change with each new alignment of classes and individuals, but also with every change in the state of the arts—institutional as well as technological.*" (1933, 216)

RESOURCES & CONSERVATION

"If petroleum resources were in their entirety available from the beginning and could not increase but only decrease through use, it might be correct to advocate 'sparing use so as to delay inevitable exhaustion.' But if petroleum resources are dynamic entities that are unfolded only gradually in response to human efforts and cultural impacts, it would seem that the living might do more for posterity by creating a climate in which these resource-making forces thrive and, thriving, permit the full unfolding of petroleum reserves than by urging premature restraint in use long before the resources have been fully developed." (1957, 8–9)

Sources: *World Resources and Industries* (Harper & Brothers, 1933); *Conservation in the Production of Petroleum* (Yale University Press, 1957).

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ela and bitumen in Alberta, Canada, are now rivals to crude oil. These are examples of Zimmermann's "resources are not, they become" that he did not live to see.

Vainly, economists working in the fixity paradigm have looked for a "depletion signal" in the empirical record—some definitive turning point at which physical scarcity overcomes human ingenuity. A new research program is in order. Applied economists should focus upon institutional change to explain and quantify changes in resource scarcity. The legal framework of a country, and even a people's customs, explain the abundance or paucity of mineral development.

The 1970s' price spikes with crude oil can be better understood in terms of human factors rather than as a depletion signal. Nature's "tank" was not running low; rather, government-imposed price ceilings distorted market processes. Similarly, today's high oil prices, at least in part, reflect an "institutional signal"—an artificial scarcity partly caused by the political blockage of oil production in the Arctic National Wildlife Refuge in Alaska and other technologically producible oil provinces around the world.

Resources grow with improving knowledge, expanding capital, and capitalistic policies, including privatization of the subsoil, that encourage market entrepreneurship. Resources shrink with war, revolution, strife, nationalization, taxation, price controls, and access restrictions. Man is the creator of resources, but man can also destroy and immobilize resources.

Whether or not oil, gas, and coal are exploited far into the future depends not only on consumer demand but also on whether government policies will allow the ultimate resource of human ingenuity to turn the "neutral stuff" of the earth into resources in ever-better ways. With this understanding, it may be appropriate to join energy economist M. A. Adelman (1997, 26) and abandon the term "exhaustible" to describe mineral resources.[2] The end of the misleading renewable-nonrenewable framework would bring Zimmermann's functional theory to full flower and improve understanding for better real-world decision making.

NOTES

1. Four such books are: Kenneth Deffeyes, *Hubbert's Peak: The Impending World Oil Shortage* (Princeton: Princeton University Press, 2001); Richard Heinberg, *The Party's Over: Oil, War and the Fate of Industrial Societies* (Canada: New Society Publishers, 2003); David Goodstein, *Out of Gas: The End of the Age of Oil* (New York: W. W. Norton, 2004); and Stephen Leeb and Donna Leeb, *The Oil Factor: Protect Yourself—AND PROFIT—from the Coming Energy Crisis* (New York: Time Warner, 2004).

2. The term "renewable" for such mainstays as hydropower or wind power can be abandoned as well. Economic, environmentally workable sites are scarce and, by depletionist thinking, limited.

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